

Generate Arbitrary Waveforms

Draw any arbitrary waveform—this generator transforms it into a repetitive electrical signal.

Most waveform generators are limited to producing either sinusoid, square-wave or ramp functions. Should any combination of sinusoid, ramp or square wave be necessary or, for that matter, if any arbitrary waveform is desired, the necessity of an alternate solution to the problem becomes evident.

One solution consists of hand-drawing the desired waveform on metallized program-chart paper with an electrical etching stylus. A high-current density at the tip of the stylus evaporates metal from the chart at the point of contact. Thus, a continuous program line drawn from one end of the chart to the other separates program-chart paper into separate electrically conductive areas. Between each metallic section and a common sensing electrode, there exists a minute capacitance. As the size of each area is varied (determined by location of the line), its capacitance changes. Program paper is wrapped about a rotating drum placed in proximity to sensor, which is held stationary. Capacitance from the two metallized segments form the variable arms of a capacitive voltage divider. Voltage at the sensing electrode is thus an exact replica of the original program drawn on the paper.

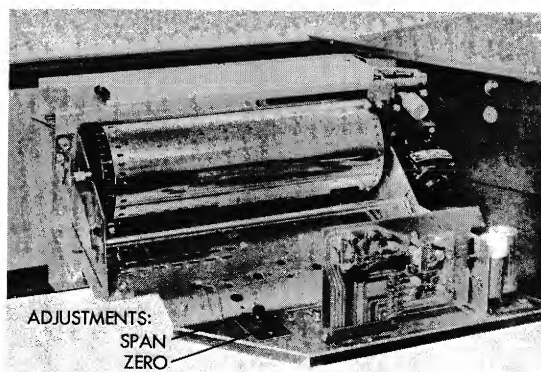
For the voltage to be usable, it must be amplified and demodulated before being delivered eventually as an output. Demodulator circuit is phase-sensitive. The flexible characteristics of the function gener-

ator, such as variable zero, variable amplitude, are handled by voltage dividers at amplifier inputs. In addition, any selected point on the waveform can be investigated by stopping the program drum without loss in the existing voltage level at that point.

The device, called the STATA-TRAK, was developed by the engineering group under the direction of James Anderson, vice president, Research, Inc., Controls Div., Minneapolis, Minn. ■

M. K. Bhatia, Midwest Editor

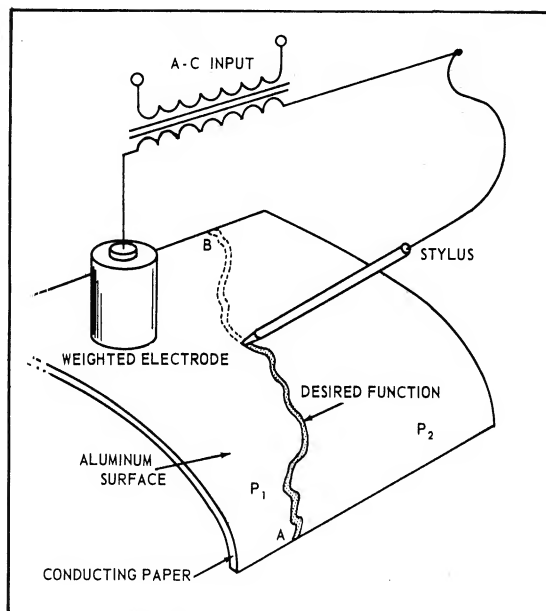
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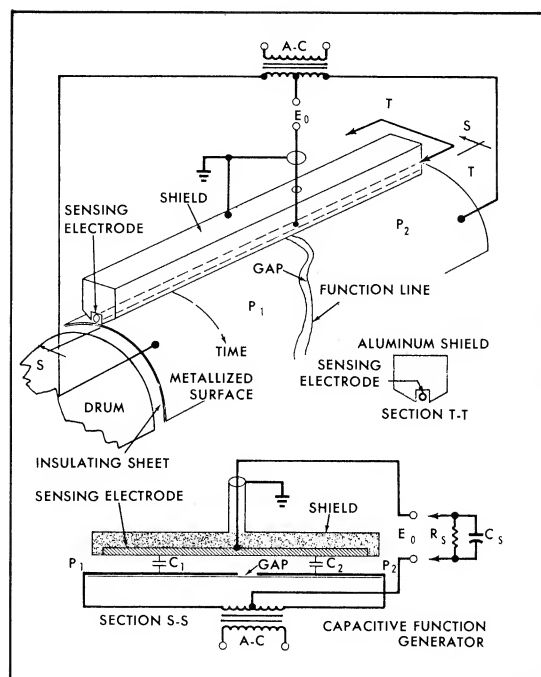
Easy access is necessary for drum removal and adjustments. Conducting paper should lie flat against drum, with ends of paper butted against each other.

(Continued)

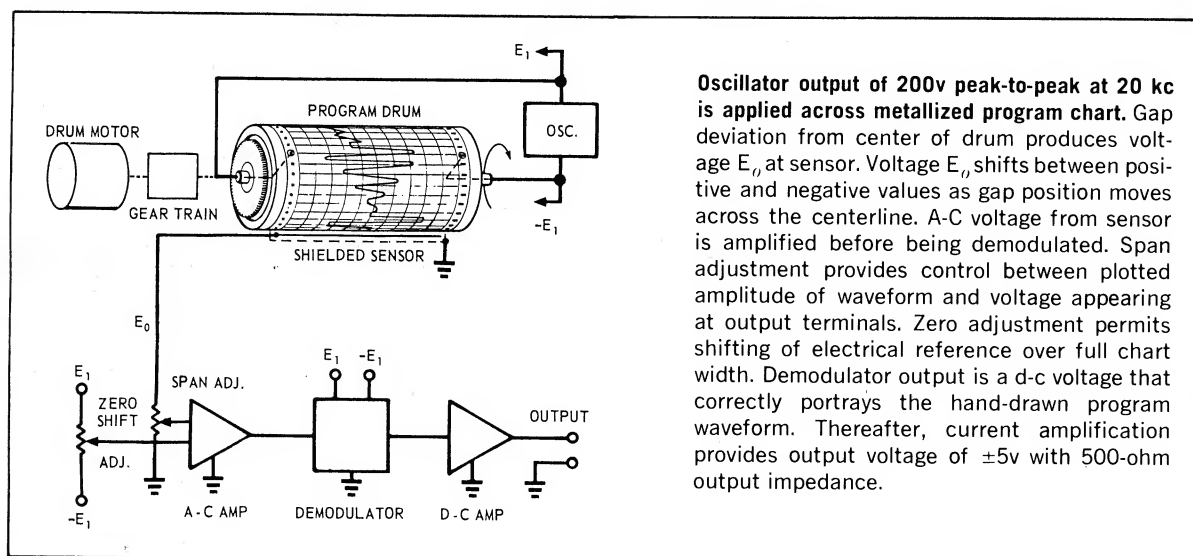
Arbitrary Waveforms (Cont'd)



To draw a desired function, paper is first placed on a flat surface. A weighted electrode is placed on a metallic surface. Electrode is connected to one end of a low-voltage a-c input, the other lead going directly to stylus. Circuit is completed through aluminum coating on paper when contacted by stylus. Current density at tip of stylus is sufficient to evaporate aluminum at point of contact, exposing a red dye underneath metallic surface. Desired waveform function is drawn by moving tip over entire length of aluminum sheet from A to B. An end-to-end function line is a must since it is essential that metallic surface be separated in two electrically isolated planes. P1 and P2.



Location and size of sensing electrode are essential to proper functioning of capacitive bridge. Sensor consists of wire embedded in milled slot in aluminum bar and insulated from bar by varnish. Bar serves as a shield and spans active width of conducting paper. Gap between wire and paper is 25 mils. Capacitance between sensor and planes P1 and P2 are C1 and C2, respectively. As drum rotates, location of gap under sensor shifts, thereby varying sizes of conducting planes P1, P2. This results in changing values of C1, C2, which affect output voltage E_o .



Oscillator output of 200v peak-to-peak at 20 kc is applied across metallized program chart. Gap deviation from center of drum produces voltage E_o at sensor. Voltage E_o shifts between positive and negative values as gap position moves across the centerline. A-C voltage from sensor is amplified before being demodulated. Span adjustment provides control between plotted amplitude of waveform and voltage appearing at output terminals. Zero adjustment permits shifting of electrical reference over full chart width. Demodulator output is a d-c voltage that correctly portrays the hand-drawn program waveform. Thereafter, current amplification provides output voltage of $\pm 5v$ with 500-ohm output impedance.



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